Claims

What is claimed is:

1. Method for monitoring the stability of the carrier frequency (ω_i) of identical transmitted signals ($s_i(t)$) of several transmitters ($S_1, \ldots, S_i, \ldots, S_n$) of a single-frequency network by evaluating the phase position of a received signal ($e_i(t)$) associated with a transmitted signal ($s_i(t)$) of a transmitter (S_i) with reference to a received signal ($e_0(t)$) of a reference transmitter (S_0), both of which are received by a receiver device (E) positioned within the transmission range of the single-frequency network.

2. Method according to claim 1, **characterised by** a calculation (S70) of a carrier-frequency displacement ($\Delta\omega_i$) of a carrier frequency (ω_i) of a transmitter (S_i) relative to a reference carrier frequency (ω_0) of the reference transmitter (S_0) from a phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) caused by the carrier-frequency displacement ($\Delta\omega_i$) of this transmitter between a phase displacement ($\Delta\Theta_i(t_{B2})$) at least at one second observation time (t_{B2}) and a phase displacement ($\Delta\Theta_i(t_{B1})$) at a first observation time (t_{B1}) of a received signal ($e_i(t)$) of this transmitter (S_i) associated with the transmitted signal ($s_i(t)$) relative to a received signal ($e_0(t)$) of the reference transmitter (S_0) associated with the transmitted signal ($s_0(t)$).

3. Method for monitoring the stability of the carrier frequency according to claim 2,

characterised in that

the calculation (S70) of the carrier-frequency displacement ($\Delta\omega_i$) of the carrier frequency (ω_i) of the transmitter (S_i) relative to the carrier frequency (ω_0) of the reference transmitter (S_0) from the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) is preceded by the procedural stages listed below:

- determination (S10) of a transmission function ($H_{SFN}(f)$) of the transmission channel from the transmitters ($S_1,\ldots,S_i,\ldots,S_n$) to the receiver device (E),

- calculation (S20) of a characteristic of a complex, time-discrete, summated impulse response ($h_{SFN1}(t)$) at the first observation time (t_{B1}) and a characteristic of a complex, time-discrete, summated impulse response ($h_{SFN2}(t)$) at the second observation time (t_{B2}) of the transmission channel respectively from the transmission function ($H_{SFN}(f)$) of the transmission channel,

- masking (S30) of a characteristic of a complex impulse response ($h_{SFN1i}(t)$) at the first observation time (t_{B1}) and of a characteristic of a complex impulse response ($h_{SFN2i}(t)$) at the second observation time (t_{B2}) for every transmitter (S_i) of the single-frequency network respectively from the characteristic of the complex, summated impulse response ($h_{SFN1}(t)$) at the first observation time (t_{B1}) and from the characteristic of the complex,

summated impulse response ($h_{SFN2}(t)$) at the second observation time (t_{B2}),

- determination (S40) of a phase characteristic ($\arg(h_{SFN1i}(t))$) of the complex impulse response ($h_{SFN1i}(t)$) at the first observation time (t_{B1}) and of a phase characteristic ($\arg(h_{SFN2i}(t)$) of the complex impulse response ($h_{SFN2}(t)$) at the second observation time (t_{B2}) for every transmitter (S_i) of the single-frequency network,

- calculation (S50) of the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) between a phase displacement ($\Delta\Theta_i(t_{B2})$) at the second observation time (t_{B2}) and a phase displacement ($\Delta\Theta_i(t_{B1})$) at the first observation time (t_{B1}) by subtraction of a phase characteristic ($\arg(h_{SFN1i}(t))$) of the complex impulse response ($\arg(h_{SFN1i}(t)$) at the first observation time (t_{B1}) from a phase characteristic ($\arg(h_{SFN2i}(t))$) of the complex impulse response ($h_{SFN1i}(t)$) at the second observation time (t_{B2}) of the respective transmitter (S_i).

4. Method for monitoring the stability of the carrier frequency according to claim 3,
characterised by

- increasing (S60) the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) by the factor $2*\pi$ in the case of a decrease in the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) to the value $-\pi$ or below and

- reducing (S65) the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) by the factor $-2*\pi$ in the case of an

increase in the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) above the value π.

5. Method for monitoring the stability of the carrier frequency according to claim 3 or 4,
characterised in that
in the case of digital terrestrial TV, the transmission function of the transmission channel from the transmitters ($S_1,\ldots,S_i,\ldots,S_n$) to the receiver device (E) is determined from the DVB-T symbols of scattered pilot carriers of received signals ($e_i(t)$) of the transmitters ($S_1,\ldots,S_i,\ldots,S_n$) modulated according to the orthogonal-frequency-division-multiplexing (OFDM) method.

6. Method for monitoring the stability of the carrier frequency according to claim 3,
characterised in that
the calculation (S20) of a characteristic of a complex, time-discrete, summated impulse response $h_{SFN1/2}(t)$ at the discrete first observation time t_{B1} of the transmission channel is derived from the transmission function $H_{SFN}(f)$ of the transmission channel using the Fourier transform according to the formula:

$$h_{SFN1/2}(t) = \sum_{k=0}^{N_F-1} H_{SFN}(k) * e^{j2\pi kt/N_F}$$

wherein

$H_{SFN}(f)$	denotes the transmission function or respectively the frequency response of the transmission channel,
N_F	denotes the number of sampling values for the discrete Fourier transform,

k	denotes the discrete frequency values,
t	denotes the sampling times of the time-discrete, summated impulse response of the transmission channel and
1/2	denotes the index for the observation time t_{B1} or respectively t_{B2}.

7. Method for monitoring the stability of the carrier frequency according to claim 6,
characterised in that
the calculation (S50) of the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B2}-t_{B1})$) for each transmitter S_i of the single-frequency network is derived according to the formula:

$$\Delta\Delta\Theta_i(t_{B2}-t_{B1}) = \arg(h_{SFN2i}(t)) - \arg(h_{SFN1i}(t))$$

wherein

i	denotes the index for the transmitter S_i
$\arg(h_{SFN2i}(t))$	denotes the phase characteristic of the complex impulse response $h_{SFN2i}(t)$ at the observation time t_{B2} of the transmitter S_i and
$\arg(h_{SFN1i}(t))$	denotes the phase characteristic of the complex impulse response $h_{SFN1i}(t)$ at the observation time t_{B1} of the transmitter S_i.

8. Method for monitoring the stability of the carrier frequency according to claim 7,
characterised in that

the calculation (S70) of the carrier-frequency displacement $\Delta\omega_i$ of the transmitter S_i relative to the carrier frequency ω_0 of the reference transmitter of the single-frequency network is derived according to the formula:

$$\Delta\omega_I = \Delta\Delta\Theta_i(t_{B2}-t_{B1})/(t_{B2}-t_{B1})$$

wherein

i	denotes the index for the transmitter S_i,
$\Delta\Delta\Theta_i(t_{B2}-t_{B1})$	denotes the phase position difference $\Delta\Delta\Theta_i(t_{B2}-t_{B1})$ for the transmitter S_i of the single-frequency network and
t_{B1}, t_{B2}	denote the observation times.

9. Method for monitoring the stability of the carrier frequency according to claim 8,

characterised in that

to allow an unambiguous identification of the permanent carrier-frequency displacement $\Delta\omega_i$ of the transmitter S_i in the single-frequency network relative to the carrier frequency ω_0 of the reference transmitter S_0 at several observation times t_{Bj}, the following procedural stages are implemented repeatedly:

- calculation (S20) of the characteristic of the complex, time-discrete, summated impulse response $h_{SFNj}(t)$ and $(h_{SFN(j+1)}(t)$ at the observation times t_{Bj} and $t_{B(j+1)}$,

- masking (S30) of the characteristic of the complex impulse response $h_{SFNji}(t)$ and $h_{SFN(j+1)i}(t)$ at

the observation times t_{Bj} and $t_{B(j+1)}$ for every transmitter S_i of the single-frequency network,

- determination (S40) of the phase characteristics $\arg(h_{SFNji}(t)$ and $\arg(h_{SFN(j+1)i}(t))$ of the complex impulse responses $h_{SFNji}(t)$ and $h_{SFN(j+1)i}(t))$ at the observation times t_{Bj} and $t_{B(j+1)}$,

- calculation (S50) of the phase-displacement difference $(\Delta\Delta\Theta_i(t_{B(j+1)}-t_{Bj}))$ between the phase displacement $\Delta\Theta_i(t_{B(j+1)})$ at the observation time $t_{B(j+1)}$ and the phase displacement $\Delta\Theta_i(t_{Bj})$ at the observation time t_{Bj} for every transmitter S_i of the single-frequency network,

- increasing (S60) the phase-displacement difference $\Delta\Delta\Theta_i(t_{B(j+1)}-t_{Bj})$ by the factor $2*\pi$ in the case of a decrease in the phase-displacement difference $(\Delta\Delta\Theta_i(t_{B(j+1)}-t_{Bj}))$ to the value $-\pi$ or below,

- reducing (S65) the phase-displacement difference $(\Delta\Delta\Theta_i(t_{B(j+1)}-t_{Bj}))$ by the factor $-2*\pi$ in the case of an increase in the phase-displacement difference $\Delta\Delta\Theta_i(t_{B(j+1)}-t_{Bj})$ above the value π and

- calculation (S70) of the carrier-frequency displacement $\Delta\omega_{ij}$ of the transmitter S_i relative to the carrier frequency ω_0 of the reference transmitter of the single-frequency network at several observation times t_{Bj};

and that following this, an averaging (S80) of all carrier-frequency displacements $\Delta\omega_{ij}$ of every

transmitter S_i relative to the carrier frequency ω_0 of the reference transmitter S_0 of the single-frequency network calculated respectively in procedural stage (S70), is implemented at the observation times t_{Bj}.

10. Method for monitoring the stability of the carrier frequency according to claim 9,
characterised in that
the averaging (S80) of all carrier-frequency displacements $\Delta\omega_{ij}$ of every transmitter S_i relative to the carrier frequency ω_0 of a reference transmitter S_0 of the single-frequency network calculated in procedural stage (S70), is implemented using a recursive method.

11. Device for monitoring the stability of the carrier frequency (ω_i) of identical transmitted signals $s_i(t)$ of several transmitters ($S_1,\ldots,S_i,\ldots,S_n$) of a single-frequency network comprising:

- a receiver device (E),

- a unit (11) for determining a transmission function $H_{SFN}(f)$ of a transmission channel of several transmitters ($S_1,\ldots,S_i,\ldots,S_n$) of the single-frequency network to the receiver device (E) disposed within the transmission range of the single-frequency network,

- a unit (12) for implementing an inverse Fourier transform,

- a unit (13) for masking a impulse response ($h_{SFNi}(t)$) for every transmitter (S_i) from the summated impulse response ($h_{SFN}(t)$),

- a unit (14) for determining the phase characteristic ($\arg(h_{SFNi}(t))$) of the impulse response ($h_{SFNi}(t)$) for every transmitter (S_i),

- a unit (15) for calculating the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B(j+1)}-t_{Bj})$) of the phase displacement ($\Delta\Theta_i$) of a transmitter (S_i) relative to a reference transmitter (S_0) at least at two different times ($(t_{B1,}-t_{Bj+1})$) and the carrier-frequency displacement ($\Delta\omega_i$) of every transmitter (S_i) relative to the carrier frequency (ω_0) of the reference transmitter (S_0) and

- a unit (2) for presenting the calculated carrier-frequency displacement ($\Delta\omega_i$) of every transmitter (S_i) relative to the carrier frequency (ω_0) of the reference transmitter (S_0) of the single-frequency network.

12. Device for monitoring the stability of the carrier wave (ω_i) of identical transmitted signals $s_i(t)$ of several transmitters ($S_1,\dots,S_i,\dots,S_n$) of a single-frequency network comprising:

- a receiver device (E),

- a unit (16) for determining a transmission function ($H_{SFN}(f)$) from pilot carriers of the received signal ($e_i(t)$),

- a unit (13) for masking a impulse response ($h_{SFNi}(t)$) for every transmitter (S_i) from the summated impulse response ($h_{SFN}(t)$),

- a unit (14) for determining the phase characteristic ($\arg(h_{SFNi}(t))$) of the impulse response ($h_{SFNi}(t)$) for every transmitter (S_i),

- a unit (15) for calculating the phase-displacement difference ($\Delta\Delta\Theta_i(t_{B(j+1)}-t_{Bj})$) of the phase displacement $\Delta\Theta_i$ of a transmitter (S_i) relative to a reference transmitter (S_0) at least at two different times ($t_{Bj}-t_{B(j+1)}$) and the carrier-frequency displacement ($\Delta\omega_i$) of every transmitter relative to the carrier frequency (ω_0) of the reference transmitter (S_0) and

- a unit (2) for presenting the calculated carrier-frequency displacement ($\Delta\omega_i$) of every transmitter (S_i) relative to the carrier frequency (ω_0) of the reference transmitter (S_0) of the single-frequency network.

13. Device for monitoring the stability of the carrier frequency according to claim 11 or 12,
characterised in that
the unit (2) for presenting the calculated carrier-frequency displacement ($\Delta\omega_i$) of every transmitter (S_i) relative to the carrier frequency (ω_0) of the reference transmitter (S_0) comprises a tabular and/or graphic display device.